

15757 U.S. PTO  
10705692



1           A. TITLE

2           **IMPROVED BRIDGE STRUCTURE**

3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26

1                   **C. KNOWN PRIOR ART**

2       **None.**

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26



18351 U.S.PTO  
111203

1        **D. DISCUSSION OF PRIOR ART AND BACKGROUND OF INVENTION**

2            The subject invention relates to bridge structures and is conceived as an  
3     improved structural arrangement that combines multiple types of support systems  
4     to increase the bridge strength and stability of the bridge.

5            The purpose of increasing a bridge strength is manifest when consideration  
6     is given to the fact that most highway bridges are now subjected to heavier loads,  
7     all with increasing frequency. This load factor is caused in large part by heavy  
8     truck traffic, along with the increased passenger vehicle traffic. These load factors  
9     yield considerable stress on a bridge's strength and stability. Railroad bridges are  
10    generally subjected to the same type of structural stress.

11           Moreover, in certain geographic areas, highways and railroad bridges are  
12    subjected to severe winds that appear to be increasing in intensity by reason of  
13    developing unusual weather patterns. These and other factors, including earth  
14    tremors, create a need for bridges of greater strength and stability, and as a result,  
15    the invention herein is conceived as a means to provide additional strengthening  
16    factor for bridges and the objects sets forth below for the subject invention are  
17    directed accordingly.

18           In discussing the variant aspects of the subject invention, note is made that  
19    the inventive concepts herein apply to suspension bridge structural concepts, arch  
20    support structures and other structural systems, such as truss bridges, beam  
21    bridges or cantilever bridges, and the fact that the subject invention is described as  
22    being directed to only a few of such types of bridge structures shall not limit the  
23    scope of the subject invention, as embraced by the following described objects.

24

25

26

15757 U.S.PTO  
10705692



1                   E. OBJECTS

2

3       It is an object of the subject invention to provide an improved bridge  
4       structure;

5       Yet another object of the subject invention is to provide an improved, multi-  
6       support bridge support structure and system;

7       Another object of the subject invention is to provide an improved bridge  
8       structure having more than one type of basic support system;

9       Still another object of the subject invention is to provide an improved  
10      structural system for improving the strength of a bridge;

11      A further object of the subject invention is to provide an improved  
12      supplemental system for increasing the base support strength of a bridge structure;

13      Yet another object of the subject invention is to provide an improved  
14      structural system for bridge support purposes;

15      It is also a purpose of this invention to provide multiple systems for  
16      supporting a single bridge structure, which multiple systems are structurally  
17      cooperative and not physically antagonistic;

18      Another purpose of this invention is to improve existing bridge structure.

19      Other objects will become apparent from a reading of the following  
20      description in conjunction with the drawings.

21

22

23

24

25

26

1                   **F. DESCRIPTION OF DRAWINGS**

2

3                   **Figure 1 is a side elevational view of the subject invention shown in the**  
4                   **overall perspective of a total bridge structure;**

5                   **Figure 2 is a perspective view of the subject under-support member used in**  
6                   **conjunction with the subject invention;**

7                   **Figure 3 is an end elevational view, in cross-section, of the subject under-**  
8                   **support member, as embracing the under surface of a bridge deck;**

9                   **Figure 4 is a side elevational view of the subject under-support member**  
10                  **shown as embracing the under surface of a bridge deck.**

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

1                   G. DESCRIPTION OF GENERAL EMBODIMENT

2                   The subject invention is an improved bridge structure comprising the  
3                   use of both arch structural support systems along with suspension systems,  
4                   combined together to support a multiple bridge support structure, with such multiple  
5                   support systems being focused and combined through a unitary member in a center  
6                   portion of the bridge, with the unitary member being an under support member in  
7                   one embodiment, with such under support member supporting a portion of the  
8                   bridge deck. More particularly, the subject invention is focused on utilizing multiple  
9                   structural support systems for a bridge, with such multiple support systems being  
10                  centered on a longitudinally extending secondary under support member, which is  
11                  supported and held partially by the supplementary bridge support system, such  
12                  secondary support member structurally having multiple and varied support systems  
13                  and being adapted to provide an under support system as a supplementary support  
14                  mechanism for the bridge structure. In summary, the subject invention comprises  
15                  a secondary support system for a bridge to provide additional support to the primary  
16                  support system for the bridge, such secondary support system having its forces  
17                  focused on an undersupport system that is positioned beneath the bridge deck as  
18                  an undersupport member that helps hold the bridge deck, along with the support  
19                  provided by the primary support system.

20                  In further summary, the subject invention is focused on the use and  
21                  deployment of an under-support member that is supported independently and  
22                  separate from the support member for the bridge, which under-support member is  
23                  basically a cradle like member that provides an uplifting force for the bridge deck.  
24                  This supporting force can be directed and applied to any portion of the bridge deck  
25                  and may include any means of system of support as supplementary to the main  
26                  support system for the bridge.

1    **H. DESCRIPTION OF PREFERRED EMBODIMENT OF SUBJECT INVENTION**

2

3       The following description of a preferred embodiment is set forth as one  
4       specific embodiment. Such description of a preferred embodiment shall not be  
5       considered as limiting the scope of the subject invention to only the type of bridge  
6       described with its multiple support systems.

7       Attention is directed at first to Figure 1 of the drawings in which a preferred  
8       embodiment of the subject invention is shown. Specifically shown in Figure 1 is a  
9       bridge member 10 incorporating features of the subject invention, such bridge  
10      member having an upper deck 20 over which deck vehicular traffic traverses. As  
11      can be seen, bridge deck 20 is generally a horizontal, longitudinally extending  
12      structure having an upper surface 30 and a lower surface 40. The upper surface  
13      of the bridge deck may be other than horizontal in some embodiments, however,  
14      and may be curved upwardly in a convex manner to increase the vertical spatial  
15      distance under the bridge for accommodation of such things as ship masts passing  
16      underneath. It is the bridge deck that is the ultimate structural object of the bridge  
17      support system which is the subject of the invention, as in any conceived bridge  
18      support system.

19       The bridge 10 and the bridge deck 20, as shown in the drawings, is  
20      structured to extend from the respective upper portions 50A and 50B of opposing  
21      banks 60A and 60B respectively framing the opposing sides of a gorge, valley,  
22      ravine or river 70 as schematically shown in Figure 1. The bridge deck 20 is, as  
23      stated above, the ultimate structural focus of any bridge support system or the  
24      multiple support system described in the application, as the bridge deck is adapted  
25      to bear the weight and stress in any bridge system. As seen, in this respect, the  
26      bridge deck 20 has opposing ends 80A and 80B affixed directly or indirectly to the

1 adjoining upper portions 50A and 50B of opposing upper banks 60A and 60B.  
2 Moreover, as seen in Figure 1, the bridge deck 20 may be comprised of two  
3 opposing horizontally projecting sections 85A and 85B adjoining at the respective  
4 mating ends 85A and 85B at what is optimally the medial portion 90 of the bridge  
5 deck. The bridge deck 20 may be formed otherwise as a unitary member or  
6 comprising more than two sections interconnected by some means.

7 Again, as stated, the deck 20 is the main focus of any bridge support system,  
8 and in this invention, the support system that is generally provided herein is a dual  
9 or multiple support system for the bridge deck 20. Thus, at all times, the bridge  
10 deck 20 in the subject invention will have a primary support structural mechanism  
11 and a secondary support system, or alternatively stated, there will be multiple  
12 support systems for the bridge 20, and either support system may be considered  
13 primary or secondary. Moreover, in the subject system, more than two support  
14 systems can be used to support the bridge structure. Furthermore, while the  
15 support systems described in the preferred embodiment are directed to suspension  
16 and arch support systems other support systems may be used to implement the  
17 concept of the subject invention. The intent of this invention is to provide such  
18 secondary support system or systems with their respective attendant support  
19 forces, so that they interact cooperatively, so that the static forces of each attendant  
20 support system does not interfere with or tend to weaken or cancel out the support  
21 forces provided by the other support systems, but rather complement one another  
22 so that the overall support system forces holding the bridge deck are augmented.

23 The foregoing bridge structure as described in the preferred embodiment is  
24 basically a conventionally-structured arch type abutment bridge utilizing opposing  
25 support arches 100A and 100B as the primary support elements for the bridge 10  
26 and bridge deck 20. This arch support structure as described is considered to be

1 conventionally-structured to be self-supporting by its intrinsic structure, and  
2 therefore, in ordinary circumstances, needs no additional support structure to  
3 uphold the bridge deck 20. Additionally, more than two arch support members may  
4 be used on a given bridge structure utilizing concepts of this invention. The  
5 subject invention is set forth as a supplemental support system for the bridge 10 as  
6 described with its attendant base arch support system. Moreover, it is noted that  
7 the concepts of this invention are equally applicable to other than arch type bridge  
8 structures.

9       The following described structural aspects, which comprise the main  
10 substance of the subject invention, are adapted to aid in the underlying support  
11 provided by opposing abutment type arch members 100A and 100B, as described  
12 above. As seen, the subject invention and the structural concepts set forth herein  
13 are adapted to be supplementary support for such base abutment arch members  
14 100A and 100B to add to the support strength for the bridge 10 as more fully  
15 described below. Moreover, it is to be stressed that more than two abutting arch  
16 members may be utilized in conjunction with the subject bridge structure.

17       More specifically as seen in the drawings and particularly Figure 1, the  
18 opposing outer ends 80A and 80B of the bridge deck 20 are integrally affixed  
19 directly or indirectly to the opposing upper portions 50A and 50B of the river banks  
20 60A and 60B, as seen. It is not critical that the opposite ends 80A and 80B of the  
21 bridge deck 20 be integrally positioned into a portion of the opposing banks 60A  
22 and 60B respectively as represented in Figure 1.

23       In the usual structural arrangement for an arch support type bridge, such as  
24 bridge 10, the bridge deck 20, as stated, is directly or indirectly supported by the  
25 arch members 100A and 100B. In the bridge 10 represented in Figure 1, the bridge  
26 deck 20 is positioned and affixed such that the approximate medial portions of the

1 und rsurface 40 of bridg d ck 20 are integrally positioned and affix d ov r the  
2 upp r surface portions 170A and 170B respectively of the r spective first and  
3 second support arch members 100A and 100B as seen. Other support and  
4 attachment means between the respective arch members and bridge deck may be  
5 utilized however.

6 Additionally, as observed in Figure 1 in the structure of bridge 10, vertical  
7 support stanchion members 180A and 180B are connected in a supporting position  
8 between the upper surface 170A of first support arch member 100A and the lower  
9 surface 40 of deck 20. In similar manner, vertical support stanchion members 190A  
10 and 190B are supportively interconnected between the upper surface portion of  
11 support arch 100B and the right portion of lower surface 40 of deck 20. As can be  
12 readily observed from the side elevational view of Figure 1, support arch members  
13 100A and 100B, with such vertical stanchion, as interconnected to the bridge deck  
14 20 are represented as being symmetrically arranged in order to achieve maximal  
15 and optimal support features for the bridge 10. However, in some circumstances,  
16 this desired symmetry cannot be realistically implemented in every circumstance.  
17 This latter facet does not detract from the implementation and realization of the  
18 structural practicality of the subject invention. Moreover, any number of vertical  
19 stanchions may be used between the arch and bridge deck without detracting from  
20 the conceptual scope of the invention herein.

21 As thusly described, the bridge 10 is structured similarly to a conventional  
22 arch type bridge, the structural arrangements of which are well known. The  
23 additional support system or systems, which are described hereafter in this  
24 application are considered unique, particularly in the manner to which the  
25 supplementary forces are direct to the under surfaces of the bridge deck. These  
26 latter innovative concepts are the focus of this patent application and are described

1 in detail as follows.

2 As an overall perspective, it is to be stressed that in the primary and  
3 preferred embodiment of the invention herein, the subject support system is focused  
4 through a support member that provides upwardly lifting forces on the bridge deck,  
5 and preferably such forces are applied directly or indirectly up through the lower  
6 surface of the bridge deck. It is not necessary, however, that the supplementary  
7 forces be applied to the under-surface of the bridge deck, but rather may be applied  
8 upwardly on any portion of the bridge deck. However, in the primary embodiment,  
9 an under-support member 200 is used as the structural mechanism to focus the  
10 supplementary force on the bridge deck as more fully described below.

11 In the embodiment shown in Figures 1, 2 and 3 the under-support member  
12 200 is shown with the upper surface 210 thereof as being relatively flat and  
13 uniplanar, or more simply as being uniformly flat. In another embodiment of the  
14 under-support member, as shown in Figure 4, the upper surface 210 of the under-  
15 support member is shown as having a slightly curved upper surface, which  
16 curvature is seen as being convex as from an upper position looking downwardly  
17 on such upper surface. In this latter respect, as more fully discussed below, the  
18 under-support member 200 is adapted to be positioned such that the upper surface  
19 210 of the under-support member 200 embraces conformingly the bottom surface  
20 portions 230A and 230B of an arbitrary length of the adjoining upper portions of  
21 opposing arch members 100A and 100B, as more particularly seen in Figures 1, 2,  
22 3 and 4. Thus if the adjoining bottom surface portions 230A and 230B of the  
23 adjoining arch members 100A and 100B are curved, the corresponding curved  
24 upper surface 210 of the under-support member 200 will more conformingly seat  
25 fully and securely against the lower surfaces 230A and 230B of the adjoining arch  
26 members 100A and 100B for focusing and directing the secondary support provided

1 by the under-support member to the lower surface of the bridge deck. In this  
2 regard, the under-support member is in turn statically supported in a lifting manner  
3 by the secondary support forces more fully discussed below.

4 It is to be stressed that upper surface 210 of under-support member 200 that  
5 embraces upwardly in a lifting manner the under surface 40 of the bridge 10 or  
6 bridge deck 20 can be correspondingly shaped or configured to conform to  
7 whatever type of bridge structure is utilized. Consequently, it is to be understood  
8 that the subject support system, with the attendant under-support member, is not  
9 limited to arch type bridges. This under-support system is further described in  
10 detail in later portions of this application below.

11 In the preferred embodiment of the subject invention, the secondary support  
12 system set forth herein, focuses its static support forces through the under-support  
13 member so that such under-support member 200, as discussed above, provides  
14 secondary lifting forces to supplement the support of the opposing arch members  
15 100A and 100B. Shown in the drawings is one example of such a secondary  
16 support system which is specifically a suspension system, as shown in Figure 1.  
17 It is understood that other support systems may be used as an additional support  
18 system for the bridge and the inventive concepts herein are not to be considered  
19 limited to a suspension system as such a secondary support system.

20 More specifically, the suspension system shown in Figure 1, is structured  
21 in its basic arrangement as being substantially conventional. To this end shown in  
22 Figure 1 is a suspension structural system 300 that is adapted to incorporate  
23 support forces to uphold under-support member 200. Included in this suspension  
24 support system 300 and attendant structures are opposing suspension support  
25 towers 310A and 310B which are respectively embedded into the uppermost  
26 portions 50A and 50B of opposing river banks 60A and 60B as seen. These

1 support towers 310A and 310B have lower base portions 320A and 320B that are  
2 fixed in position, extending vertically upwardly, as seen. The upper ends 330A and  
3 330B of each support tower 310A and 310B are preferably, but not essentially, at  
4 an equal height to each other relative to a base point such as the bridge deck 20  
5 or some other base reference point, however, this latter feature is not critical.

6 As can be seen from the drawings, the respective suspension support towers  
7 310A and 310B have at least one set of primary bridge support cables, such as  
8 cables 340A and 340B and cables 350A and 350B for suspension support.  
9 Additional support cables may be utilized. Each of these support guy cables are  
10 generally anchored at a distance away from the bridge 10 and towers 310A and  
11 310B. The suspension support towers 310A and 310B generally each have one or  
12 more direct tower support cables such as cables 360A and 360B extending  
13 downwardly from upper portions of each suspension support tower, with attachment  
14 indirectly or directly to some portion of the ground for supporting the towers. In the  
15 embodiment shown in the drawings, the primary support cables 340A and 340B and  
16 350A and 350B extend downwardly to the bridge 10 from suspension support tower  
17 310A and 310B which each such suspension cable extending downwardly towards  
18 the center portion of bridge 10. As shown in the drawings, it must be indicated that  
19 the number of suspension support cables, as well as the number of suspension  
20 support towers, and the precise structure thereof may vary from that described first  
21 above. Moreover, stress is to be made that the subject suspension system as  
22 described is relatively simplistic and is relatively standard or conventional as  
23 described to this point. The inventive concept of the invention herein is centered  
24 on the use of a secondary support system of bridge 10 provided by the above  
25 described suspension support system, as preferably directed upon and otherwise  
26 focused with the attendant static forces of the secondary support system on the

1 under-support member 200 as briefly described above and more fully described  
2 below. To this end, the suspension support cables 340A and 340B from suspension  
3 support tower 310A are affixed to a portion of the under-support member 200 so to  
4 provide upwardly lifting support for such under-support member, and in similar  
5 fashion suspension support cables 350A and 350B emanating from the suspension  
6 support tower 310B are also connected to a portion of the under-support member  
7 200; as seen. It is optimal for this latter purpose that the respective suspension  
8 cables 340A and 340B and 350A and 350B be connected to a portion of the under-  
9 support member 200 with each set of cables affixed in equi-posed disposition on the  
10 under-support member 200 relative to one another. This connection is for basic  
11 symmetry and balance purposes, as seen in Figure 1 so that the under-support  
12 member 200 is supported by the respective cable members and is held in a level  
13 position relative to a base horizontal reference, or any other point of reference.

14 The general function of the under-support member 200, as set forth above,  
15 is to help provide additional support for the opposing abutting arch members 100A  
16 and 100B in the support function of bridge 10, with the static upwardly pulling forces  
17 provided by the suspension cable members 340A and 340B and 350A and 350B.  
18 For this purpose, the under-support member 200 is adapted to function as a lifting  
19 member independently supported irrespective of whether the arch support members  
20 100A and 100B directly and physically abut each other or are directly supportive of  
21 the bridge deck 20, or even with each such arch directly contacting each other.

22 As can be determined, both the vertical and horizontal static force  
23 components of each such support arch member 100A and 100B provide necessary  
24 upward support for bridge deck 20, as well as the necessary horizontal forces to  
25 statically project the respective adjoining horizontal portions of the bridge deck 20  
26 towards one another. In some bridge structural arrangements, more than two

1 upright arch members may be used as basic support structures, however, and the  
2 concepts of the invention herein will be equally applicable in such latter  
3 circumstances.

4 Specific attention is directed to Figures 1, 2, 3, and 4 demonstrating the  
5 supplementary under-support structure which is focused on the under-support  
6 member 200 that is basically formed as a longitudinally extending member having  
7 a longitudinally extending base member 205 that extends over the longitudinal  
8 extent of the under-support member with opposing ends 400A and 400B on the  
9 under-support member. More particularly, the under-support member 200 is a  
10 longitudinally extending member with an upper surface 210 and a lower surface 225  
11 and may be of such a length that equals the entire length of the bridge deck 20 or  
12 may be shorter relative to the length of the bridge deck, as shown in Figure 1.

13 In the preferred embodiment of the subject invention, the under-support  
14 member 200 has laterally disposed upwardly extending support walls 430A and  
15 430B that extend partially or completely along the entire length of the under-support  
16 member 200. As stated, in the embodiment shown in the drawings, the lateral  
17 support walls 430A and 430B are vertically disposed and integrally affixed to  
18 opposing lateral sides 440A and 440B of the under-support member, along the  
19 entire length of the under-support member 200, as seen. In the embodiment shown  
20 in the drawings, the lateral, vertically disposed support walls 430A and 430B are  
21 joined to the base member 205 of the under-support member 200 such that the  
22 lateral walls are disposed perpendicular to the upper surface 210 of the base  
23 member of the under-support member 200 as seen. This latter perpendicular  
24 relationship is not critical to the subject invention and is not essential that the lateral  
25 side walls 430A and 430B described be disposed along the precise sides of the  
26 under-support member. It is also not mandatory to implementation of the subject

1 invention that there be lateral walls affixed or formed on the base member 205 of the  
2 under-support member 200, so long as there is some means to affix auxiliary  
3 supporting members such as suspension support cables described above to the  
4 base member.

5 As can be seen from Figures 2, 3 and 4, the under-support member 200, with  
6 its longitudinally extending base member 205 and laterally disposed vertical walls  
7 430A and 430B form what may be viewed as a longitudinally extending channel  
8 shaped member being open at the top as well as open or exposed at its opposing  
9 ends. What is thus essentially formed is a channel shaped cradle like member  
10 formed as the basic structure for the under-support member 200 in the main  
11 embodiment of the invention. However, as described other structural arrangements  
12 may be used for the under-support member and it may be limited to a flat uniplanar  
13 member or any other structural arrangements that can focus uplifting forces  
14 upwardly to the bridge deck.

15 As shown in the drawings, the suspension cable members 340A and 340B,  
16 and 350A and 350B may be attached to the under-support member 200 by being  
17 affixed to portions of vertical side walls 430A and 430B as seen in Figures 2, 3 and  
18 4, or may be affixed to side or other portions of the base member 205 of the under-  
19 support member 200 if the under-support member has no vertical sidewalls. Other  
20 attachment arrangements may be used in this regard.

21 In some embodiments of the subject invention, the under-support member  
22 may be formed as an enclosed sleeve member having a hollow longitudinally  
23 extending chamber into which chamber the mating ends of support arches 100A and  
24 100B are placed along and adjoining portions of the bridge deck. Other enclosed  
25 or open structural arrangements may be used for the bridge under-support member.

26 As stated above, the under-support member 200 as supported by the

1 described suspension cables, is positioned under the lower surfaces 230A and 230B  
2 of the abutting arch members 100A and 100B, in a conforming manner so that th  
3 upper surface of the under-support member conformingly embraces in a flush  
4 manner such undersurface areas of the abutting arch members. This upward pull  
5 by the suspension cables 340A and 340B and 350A and 350B is such that the upper  
6 surface 210 of the under-support member 200 is drawn upwardly against the  
7 immediately adjoining under surfaces 230A and 230B of the abutting arch members  
8 100A and 100B, as seen in the drawings. In this regard, the length of the under-  
9 support member 200 is shown as being relatively short and the upper surface areas  
10 of the opposing arch members may be relatively flat, as shown in the embodiments  
11 in Figures 2 and 3, however, on the other hand, as stated, if the under-support  
12 member 200 is relatively long, the upper surface 205 is preferably curved, slightly  
13 upwardly, to accommodate the curvatures of the surfaces of the abutting arch  
14 members. This latter feature functions to both maximize the impact of the upward  
15 static forces from the suspension members described as well as evenly distributing  
16 the force load over and to the lower surfaces of the abutting arch members. This  
17 latter facet will maximize the supportive feature of the under-support member 200  
18 as seen in the drawings and as described. Moreover, in order to maximize the  
19 support, the under-support member 200 is best placed under the medial part of  
20 bridge deck 20, however, this aspect is not critical to the implementation of the  
21 subject invention.

22 One of the advantages of the subject invention is that the under-support  
23 member, as supported by the suspension system or other support system, can be  
24 used to retrofit an otherwise weakened bridge structure where the main support  
25 system has been weakened by erosion or deterioration of the components of the  
26 main support system. This retrofitting can obviously be accomplished by positioning

1 the under-support system under the existing bridge deck with some form of auxiliary  
2 support such as the suspension system described above. Moreover, in some  
3 embodiments, the under-support member may be braced directly up against the  
4 lower surface of the bridge deck. This aspect is not shown in the drawings.

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26